Field Observations of the Behaviour of Free-ranging Eastern Barred Bandicoots, *Perameles gunnii,* at Hamilton, Victoria.

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Abstract

A total of 23 individual and 10 social behavioural acts were observed in a free-ranging population of Eastern Barred Bandicoots at Hamilton. Individual behaviour involved acts relating to body posture during feeding, grooming and investigation. Mating behaviour was promiscuous. Copulations between individuals were rapid and repeated intermittently for up to 45 minutes. Intromissions occurred when the female carried advanced pouch young. Many males gathered and mated with females during their receptive period. Males used olfaction in the location and pursuit of receptive females. Mutual avoidance behaviour was often maintained between bandicoots although several antagonistic interactions were observed. These interactions usually resulted in the flight of the subordinate after strike, chase and/or threat vocalisation occurred.

Introduction

Although relatively widespread in Tasmania, Eastern Barred Bandicoots, *Perameles gunnii* are critically endangered on mainland Australia (Seebeck, *et al* 1990; Dufty 1991a). The remnant free-ranging mainland population persists at Hamilton, Victoria (Moon 1984; Brown 1989) and as a safeguard against extinction, the species has been reintroduced to several locations on the volcanic plains (Seebeck 1990).

Little information regarding individual and social behaviour of the species on mainland Australia has been published. Coulson (1990) reviewed several behavioural studies in Tasmania and Victoria and concluded that there was an urgent need for detailed information. Fagen and Goldman (1977) demonstrated that the recording of unique behavioural acts often increase considerably with increased time devoted to observation of behaviour. Thus, less frequently-exhibited behaviours may not be observed without considerable effort, and it is likely that the complete behavioural repertoire of *P. gunnii* is yet to be revealed. Heinsohn (1966) in Tasmania, and Brown (1989) and Dufty (1991a) in Victoria have commented briefly on observed individual and social behaviours of *P. gunnii* but the only systematic research so far reported is that of Moloney (1982) and Clunie (1987) who undertook 165 and 65 hours of observation respectively on captive bandicoots in Tasmania.

This paper reports on field observations at Hamilton and assists in the compilation of a behavioural reportoire for free-ranging Eastern Barred Bandicoots, *Perameles gunnii.* Also, the paper discussed the implications of *P. gunnii* behaviour to the management of both the free-ranging and captive populations in Victoria.

Methods

Observations of individual and social behaviour were undertaken during monthly spotlighting sessions within the City of Hamilton, Victoria (37°45' S, 142°02' E. A 100 Watt quartz-halogen spotlight powered by a 12 Volt gel type battery was used at night to observe bandicoot behaviour. A total of 42 spotlight hours was logged between 5 July 1989 and 30 September 1990. A raised area of ground that overlooked optimal bandicoot nesting and foraging habitat at the Hamilton Municipal Tip was used to initiate observations of individual and social behavior. Observations were conducted immediately after dusk and were confined to one individual until it moved out of sight (usually between 2-3 hours). Bandicoots appeared to be unperturbed by the spotlight and the observers' presence.

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That is, no escape behaviour that could have been attributed to the observers' presence and no erratic or unusual behaviour (excessive grooming or sniffing of the air) was observed. Information on behavioural acts observed and general notes on the frequency of these acts was recorded. Other information recorded (if possible) during encounters included: individual identification, sex, age class and reproductive state (presence/absence of pouch young or young at foot).

Results

Individual behaviour

A total of 23 distinct individual behavioural acts was observed. They are listed in Table 1, and described using the terminology of Moloney (1982) and Clunie (1987) as reviewed by Coulson (1990). Three behaviours ('bipedal stance', 'prancing' and 'climbing') which were recorded by Moloney (1982) and Clunie (1987) were not observed during this study.

Foraging areas at the Hamilton Municipal Tip were associated with hard shelter and located in a patch arrangement. Travelling within open areas between foraging patches occurred rapidly, and foraging was observed only when individuals were within 30m of shelter. Foraging ('dig', 'feed') was maintained for between 5 and 25 minutes in a single foraging patch before the bandicoot's 'run' to the next patch. Bandicoots appeared to search for food in a random movement, although two individuals were observed following fencelines for 25 and 17 minutes respectively. Nosing the ground with a lateral movement of the snout and loud snuffling noises preceeded all observed 'dig' behaviour. Digging was similar between all individuals and involved thrusting the foreclaws into a very localised area of the ground quickly and alternately and withdrawing them upwards and backwards. During digging, the hindquarters were raised, the back arched and the snout pointed downwards towards the excavation. No attempt was made to remove soil which collected under the body during digging. The snout probed the hole periodically and a sniffing or snuffling noise was audible. When the food item was secured, the individual fed immediately, while adopting a quadrupedal or sitting stance. A high foraging success was observed and often bandicoots would probe and sniff foraging holes that had been dug on other nights, sometimes enlarging these excavations. The excavations made during bandicoot foraging are conical pits, up to 80 mm deep. It is possible that they trap small invertebrates as Mr N. Gunn *(pers. comm.,* 1989) has observed bandicoots

Table 1. Individual behavioural acts observed in free-ranging Eastern Barred Bandicoots at Hamilton.

Act	Description
Quadrupedal	Manus and pes both resting on substrate, body raised and head slightly lower than parallel to body.
Tripedal	As above, but one forepaw retracted to body
Crouch	Complete manus and pes resting on substrate, back arched, head raised and forequarters lowered.
Huddle	As for crouch, but hindquarters relaxed and head lowered to substrate and manus sometimes tilted to one side.
Rear	Hindlimbs in contact with substrate, head vertically extended.
Sit	As for rear but head not extended
Walk	Slow quadrupedal locomotion, cursorial motion of pectoral girdle while saltatorial motion of pelvic girdle.
Run	Faster quadrupedal locomotion
Gallop	Rapid locomotion, wherein forelegs are retracted to body while hindlegs exhibit powerful simultaneous thrusts.
Leap	Vertical spring (up to 1 m), using sudden extension of hindlegs.
Honk	Loud grunt, repeated up to 5 times.
Nose	Lateral movement of snout across the substrate with audible sniff.
Dig	Excavating substrate with forelimbs and inserting snout in hole.
Feed	Ingesting food; large items (e.g. nectarines) held on substrate while smaller items. (e.g. insects) are manipulated while sitting
Manipulate	Clasping and rotating items (generally food) with forepaws.
Push	Hindlegs and tail in contact with substrate, forelimps brought down and away from body during extension.
Scrape	Pulling nesting materials backwards with forepaws.
Scratch	Raking movements of hindfeet to groom fur (especially head and neck).
Wipe	Rubbing the snout with licked forepaws.
Lick	Licking and chewing fur on body (except head and neck).
Shake	Vigorous shaking of body, sometimes while in motion.
Stretch	Forepaws extended under head, body elongated, accompanied by yawning.
Rest	Lying on side in loose coil.

searching and removing invertebrates from foraging holes dug previously.

Occasionally during foraging a bandicoot was observed to 'rear' in an upright stance while smelling the air. When unusual stimuli were encountered, a 'tripedal' or 'crouch' stance was adopted, often followed by a rapid 'gallop' or 'sprint', On three occasions after these responses, the bandicoot was observed to 'leap' up to 1 m into the air and then 'run' away in the direction it faced upon landing. The direction appeared to be random as all three bandicoots turned in a wide arc of up to 180 degrees, passed cover and returned to shelter, close to where they were originally.

Drinking was observed only once. The bandicoot spent four minutes lapping water that had collected in a fold of plastic, with a forward and upward motion of the tongue.

Nest construction behaviour was observed once. Dead grass within 1.5 m of the nest site was scraped from the ground around perennial tussocks and dragged or pulled backwards into an upturned galvanised iron roof gutter by the forelegs (for descriptions of nests see Dufty 1991a).

Four bandicoots were observed emerging from diurnal nests. Movement within the nest increased during the 15 minutes prior to emergence. Immediately after emergence, bandicoots were observed to 'shake' before they ran or walked to nearby foraging areas. Grooming ('scratch', 'wipe', 'lick') behaviour was most often observed after nest emergence when the individual was away from the nest within a foraging area. Upon retiring to the nest after nocturnal foraging, bandicoots were observed to move nest materials (grass and small sticks) across the nest entrance with their snouts.

Social behaviour

Mutual avoidance behaviour predominated throughout the observation periods but on four occasions social interactions were observed. Social behaviour acts are summarised in Table 2.

Aggression ('chasing' and 'striking') was observed on three occasions. During one interaction, the pair of bandicoots faced each other in the 'arched' stance with their mouths agape revealing their incisor, canine and premolar teeth. Eye contact was maintained between bandicoots and after about two minutes in this posture. The subordinate then slowly turned to move away and the aggressor was observed 'striking' the subordinate on its hindquarters. The subordinate fled 'honking' with the aggressor in 'chase'. On another occasion a 'chase' had entered the area where a third bandicoot (male) was being observed. The 'chase' passed the third bandicoot within 4 m and he responded by pursuing the pair for a distance of about 20 m. The male then returned and continued foraging. The third occasion where aggression was observed occurred when an aggressor entered a foraging patch occupied by a subordinate. The aggressor foraged about 15 m away from the subordinate for about 30 minutes, apparently unaware of the subordinate's presence. However, on moving downwind of the subordinate and sensing its presence (indicated by sniffing the air in a reared stance), the aggressor 'chased' the subordinate, causing the subordinate to 'spit' and run for shelter. The aggressor stopped the 'chase' in the area where the subordinate was foraging and continued to forage in that area.

Table 2. Social behaviourat acts observed in free-ranging Eastern Barred Bandicoots at Hamilton.
(*observed by Mr K. Drinkell or Mr N. Gunn).

Act	Description
*Perineal	Nosing perineal area of conspecific.
*Follow	Persistent following of female by male.
*Mount	Male rears on hindlimbs and inclines body forward over female.
*Thrust	Pelvic thrusting during mounting.
*Bite	Male bites female.
Arched	As for quadrupedal but head slightly lowered and back arched.
Striking	Striking conspecific on the back with forepaws.
Chase	Chasing retreating subordinate.
Honk	Honking vocalisation given by the retreating subordinate.
Spit	Spitting vocalisation given by the retreating subordinate.

Not all interactions were aggressive: on one occasion three bandicoots were observed foraging within about 10 m of each other for about 20 minutes. During this observation foraging was the principal activity and no overt social interaction (mating, vocalisation, or chase) was observed even when two bandicoots moved to within 2 m of each other. Unfortunately, the sex of only one of the bandicoots (a female with advanced pouch young) was determined and the group gradually dispersed in different directions.

Two local residents at Hamilton (Mr Ken Drinkell and Mr Noel Gunn) have recorded mating behaviour on several occasions. Their descriptions are reported below.

Mr Drinkell has lived adjacent to the Hamilton Municipal Tip for many years and has recorded information on breeding activity since 1988. Two individual females were resident on his property during the study, individuals numbered R41 and L8 R7. Female R41 was first marked on 7 May 1988, south of the Hamilton Municipal Tip when she was about four months old, while L8 R7 was first marked on 6 February 1990 on Mr Drinkell's property when she was also four months old. R 41 was first trapped on Mr Drinkell's property (about 400 m from where she was first marked) on 13 September 1988 and was regularly observed there subsequently. R 41 was observed mating with males about every 9 weeks and was the only breeding female to be observed on his property until March 1990, when female L8 R7 was observed mating.

Although many males gathered during the female's receptive period, little aggression appeared to occur between them and avoidance behaviour was maintained. No spatial organisation (e.g. lek) or obvious dominance hierarchy was apparent. Males spent much of their time searching for the females in rapid, erratic movements. These male movements increased when more males were present. When a male picked up the scent of a female, the movements of the female were replicated exactly and males were observed bumping into objects placed by Mr Drinkell on the female scent path. Up to ten males were observed to copulate with a female, three or four times each. Copulation lasted about 20-30 seconds and was repeated every few minutes for more than an hour. During one period, R41 was observed mating with male L8 R53 four times and male L61 R8 six times as well as with other males whose identity was unknown. After mating with one male, the female was observed to move away while the male was foraging and sometimes mated shortly afterwards with another male.

Mr Gunn has maintained a captive breeding pair of bandicoots on his property outside Hamilton since 1984. The bandicoots are maintained within 20 m^2 enclosures and given supplementary food every second night. This has provided Mr Gunn with the opportunity for casual observations of captive bandicoot behaviour. During or before supplementary feeding, Mr Gunn has recorded *P. gunnii* mating activity on four occasions (9 July 1988 for 15 minutes, 4 October 1989 for 45 minutes, 29 July 1990 for 17 minutes, 25 September 1990 for 20 minutes).

All observations of mating were made during late afternoon, before sunset and either during or after light rain. Copulation was initiated by the male checking the female by a 'bite' to the loose skin on her hindquarters. As the male 'mounted', the female lowered her forequarters and raised her hindquarters. On three of the mating occasions, the female was carrying advanced pouch young and during the fourth the dependent juveniles jumped around the copulating pair. Copulation involved rapid 'thrusts' and lasted between 5 and 30 seconds. As copulation progressed, the mail curled his tail under his body from an initial lateral position. Between copulation events, the male was observed to 'follow' the female's scent closely and he was often observed foraging within 1 m of her (the pair usually avoided each other during non-mating periods). The male was often observed to smell the perineal region of the female

prior to copulation. Intermissions between copulations usually lasted between 5 and 40 seconds and on 29 July 1990, copulation was observed to take place 17 times in 17 minutes.

Discussion

During this study and others (Heinsohn 1966; Duffy 1991a) bandicoots spent much of their time foraging and feeding, suggesting that dietary items sought are either low in energy or are hard to find. The high success at securing subterranean morsels observed during this study and the depth of foraging holes (up to 80 mm), suggest that bandicoots possess well developed olfaction. The dependence on olfaction to detect food resources has previously been reported by Heinsohn (1966), Moloney (1982) and Quin (1985) in Tasmania, and Dufty (1991a) in Victoria. The observation that bandicoots utilise fencelines during foraging may be due to the lack of structural complexity at Hamilton, although the higher floristic diversity and lower compaction of these areas may also be important. The lack of extensive fat deposits (Lenghaus *et al.* 1990), aggressive defence of foraging patches and rare aggregations of bandicoots suggest that food resources at Hamilton are limited.

Aggressive defence of foraging resources appeared to be the most common social behaviour exhibited during this study. Dominant individuals were observed chasing subordinates from and temporally occupying foraging areas. Heinsohn (1966) suggested that a dominance hierarchy was present and that smaller bandicoots were chased from key foraging patches. At most other times during the study, bandicoots exhibited strict avoidance behaviour and are regarded by Stodart (1977) and Russell (1984) as solitary. Although it was not clear what mechanism operates to maintain the dominance hierarchy, Russell (1985) argued that bandicoot olfaction may have a primary role. Male and female bandicoots possess a sub-auricular gland which exudes a pungent odour (Stoddart 1980) and it is likely that this odour is central to social interactions. Stoddart (1980) speculated that the odour has a calming effect which facilitates mating, while it may also be integral to the maintenance of dominance hierarchy.

Mating acts in Victoria described here by Mr Drinkell and Mr Gunn were similar to those described by Heinsohn (1966) in Tasmania. Heinsohn (1966) observed mating behaviour once in captivity and twice between free-ranging individuals. One striking difference was the high competition for receptive females at Hamilton. Drinkell reported that small aggregations of bandicoots occurred during the female's receptive period and that several males mated with the female.

Principally, the conservation of *Perameles gunnii* in Victoria has involved the establishment of three reintroduction and two captive breeding colonies (Seebeck 1990; Dufty 1991b). The artificial nature of captive breeding may alter the individual and social behaviours observed in free-ranging population and compromise the long-term viability of *P. gunnii*. To avoid this, three strategies were integral to the *P. gunnii* captive breeding programme: avoid domestication (either through human association or selective breeding for individuals that are easy to manage in captivity); minimize antogonistic interactions between colony members, and mimic the free-ranging populations' mating strategy.

Domestication of *P. gunnii* may reduce the species' ability to survive in a natural environment (e.g. forage for food, avoid predators or attract mates). To lessen the effects of domestication, individuals were seldom handled, encouraged to forage and feed without supplementation and after reintroduction, were allowed to select mates without imposition. Antagonism between captive colony residents may cause injuries, increase stress levels and lower reproductive output. To minimise antogonistic interactions, only one male resided in each breeding pen, low densities of individuals were maintained, juveniles were removed as soon as they

became independent, food was supplemented when needed, and shelter was provided for fleeing subordinates. Despite a promiscuous mating system prevailing in the free-ranging population, *P. gunnii* were initially bred in pairs to maximise outbreeding and conserve low density alleles. However, individuals were promiscuous in the reintroducted populations that were large, less influenced by genetic stoichasticity, and regulated by naturally selection.

The successful management of *Perameles gunnii* captive breeding and reintroduction in Victoria has been due, in part, to the resolution of many problems that were associated with captivity and the species' individual and social behaviour. The application of behavioural information has aided the conservation of Eastern Barred Bandicoots in Victoria and should be seen as an important component of all wildlife management programmes.

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